TOTAL MAXIMUM DAILY LOAD (TMDL)

For

Fecal Coliform

In

North St. Lucie
(WBID 3194)

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AWT	Advanced Waste Treatment
BMP	Best Management Practices
BPJ	Best Professional Judgment
CFS	Cubic Feet per Second
DEM	Digital Elevation Model
DMR	Discharge Monitoring Report
EPA	Environmental Protection Agency
F.A.C.	Florida Administrative Code
GIS	Geographic Information System
HUC	Hydrologic Unit Code
LA	Load Allocation
MGD	Million Gallons per Day
MOS	Margin of Safety
MPN	Most Probable Number
MS4	Municipal Separate Storm Sewer Systems
NASS	National Agriculture Statistics Service
NLCD	National Land Cover Data
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
OSTD	Onsite Sewer Treatment and Disposal Systems
PLRG	Pollutant Load Reduction Goal
Rf3	Reach File 3
RM	River Mile
STORET	STORage RETrieval database
TMDL	Total Maximum Daily Load
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WBID	Water Body Identification
WLA	Waste Load Allocation
WMP	Water Management Plan
WWTF	Wastewater Treatment Facility

SUMMARY SHEET
Total Maximum Daily Load (TMDL)

1. **303(d) Listed Waterbody Information**
   State: Florida
   Major River Basin: St. Lucie River Basin

Impaired Waterbodies for TMDLs (1998 303(d) List):

WBID	Segment Name and Type	River Basin	County	Constituent(s)
3194	North St. Lucie	St. Lucie	St. Lucie	Fecal Coliform

2. **TMDL Endpoints (i.e., Targets) for Class III Waters (fresh and marine):**
   Fecal Coliform: 400 MPN/100ml

3. **Fecal Coliform Allocation:**

WBID	$WLA_{Continuous}$	WLA_{MS4}	LA	TMDL	Reduction
3194	88 percent reduction	88 percent reduction	88 percent reduction	88 percent reduction	88%

4. **Endangered Species (yes or blank): Yes**

5. **EPA Lead on TMDL (EPA or blank): EPA**

6. **TMDL Considers Point Source, Nonpoint Source, or both: Both**

7. **Major NPDES Discharges to surface waters addressed in TMDLs: None**

TOTAL MAXIMUM DAILY LOAD (TMDL)
FECAL COLIFORM IN NORTH ST. LUCIE WATER BODY ID

1. INTRODUCTION

Section 303(d) of the Clean Water Act requires each state to list those waters within its boundaries for which technology based effluent limitations are not stringent enough to protect any water quality standard applicable to such waters. Listed waters are prioritized with respect to designated use classifications and the severity of pollution. In accordance with this prioritization, states are required to develop Total Maximum Daily Loads (TMDLs) for those water bodies that are not meeting water quality standards. The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and in-stream water quality conditions, so that states can establish water quality based controls to reduce pollution from both point and non-point sources and restore and maintain the quality of their water resources (USEPA, 1991).

The State of Florida Department of Environmental Protection (FDEP) developed a statewide, watershed-based approach to water resource management. Under the watershed management approach, water resources are managed on the basis of natural boundaries, such as river basins, rather than political boundaries. The watershed management approach is the framework FDEP uses for implementing TMDLs. The state's 52 basins are divided into 5 groups. Water quality is assessed in each group on a rotating five-year cycle. The Group 2 basin is shown in Figure 1 and includes the St. Lucie and Loxahatchee River Basins. The St. Lucie and Loxahatchee Basins encompass many square miles. To provide a smaller-scale geographic basis for assessing, reporting, and documenting water quality improvement projects, the FDEP subdivided the Group 2 area into smaller areas called planning units. Planning units help organize information and management strategies around prominent subbasin characteristics and drainage features. To the extent possible, planning units were chosen to reflect subbasins that had previously been defined by the South Florida Water Management District (SFWMD). The St. Lucie and Loxahatchee Basins contain eight planning units: C-25/Basin 1, North St. Lucie, C-24, C-23, South St. Lucie, C-44, Loxahatchee, and Coastal. Water quality assessments were conducted on individual waterbody segments within planning units. Each waterbody segment is assigned a unique waterbody identification (WBID) number. Waterbody segments are the assessment units or polygons that have historically been used by the FDEP to define waterbodies in their biannual inventory and reporting of water quality to EPA under Section 305(b) of the federal Clean Water Act. The same WBIDs are also the assessment units identified in the FDEP's biannual lists of impaired waters submitted to EPA as part of their reporting under Section 303(d) of the Clean Water Act.

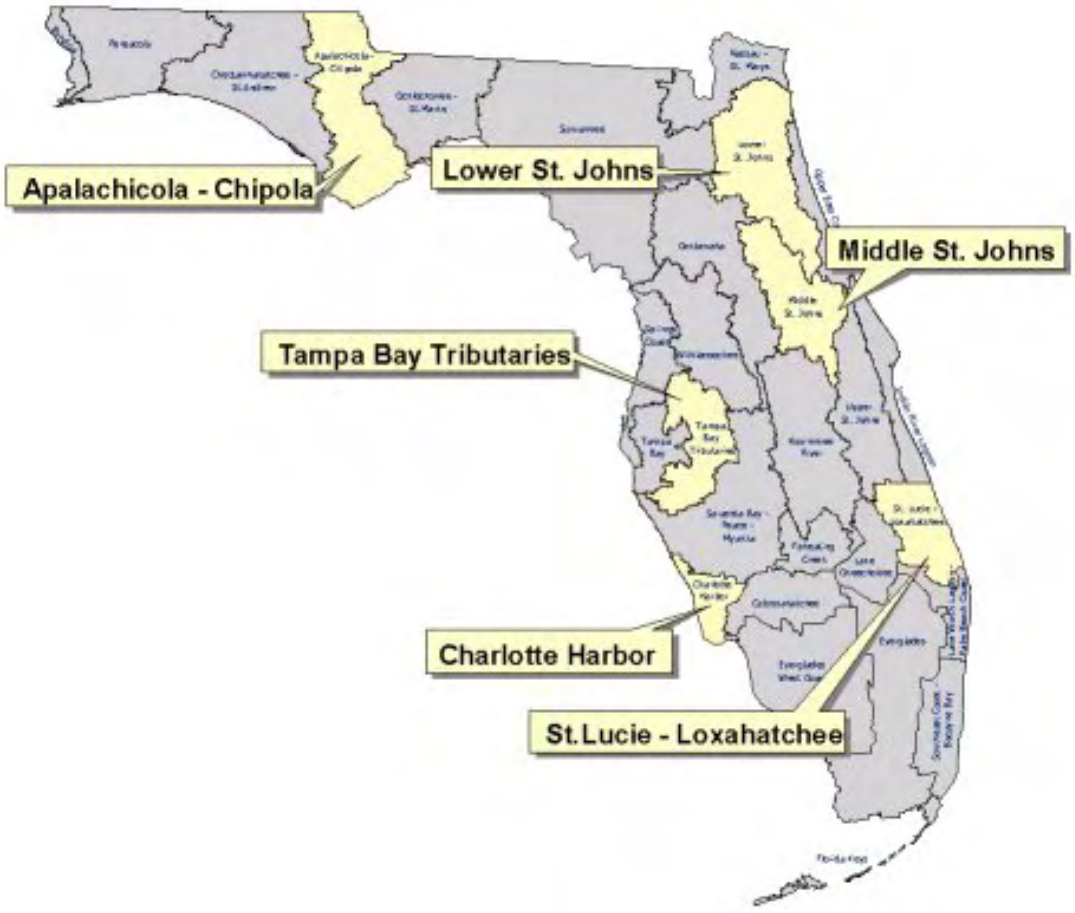

Figure 1: FDEP Group 2 River Basins

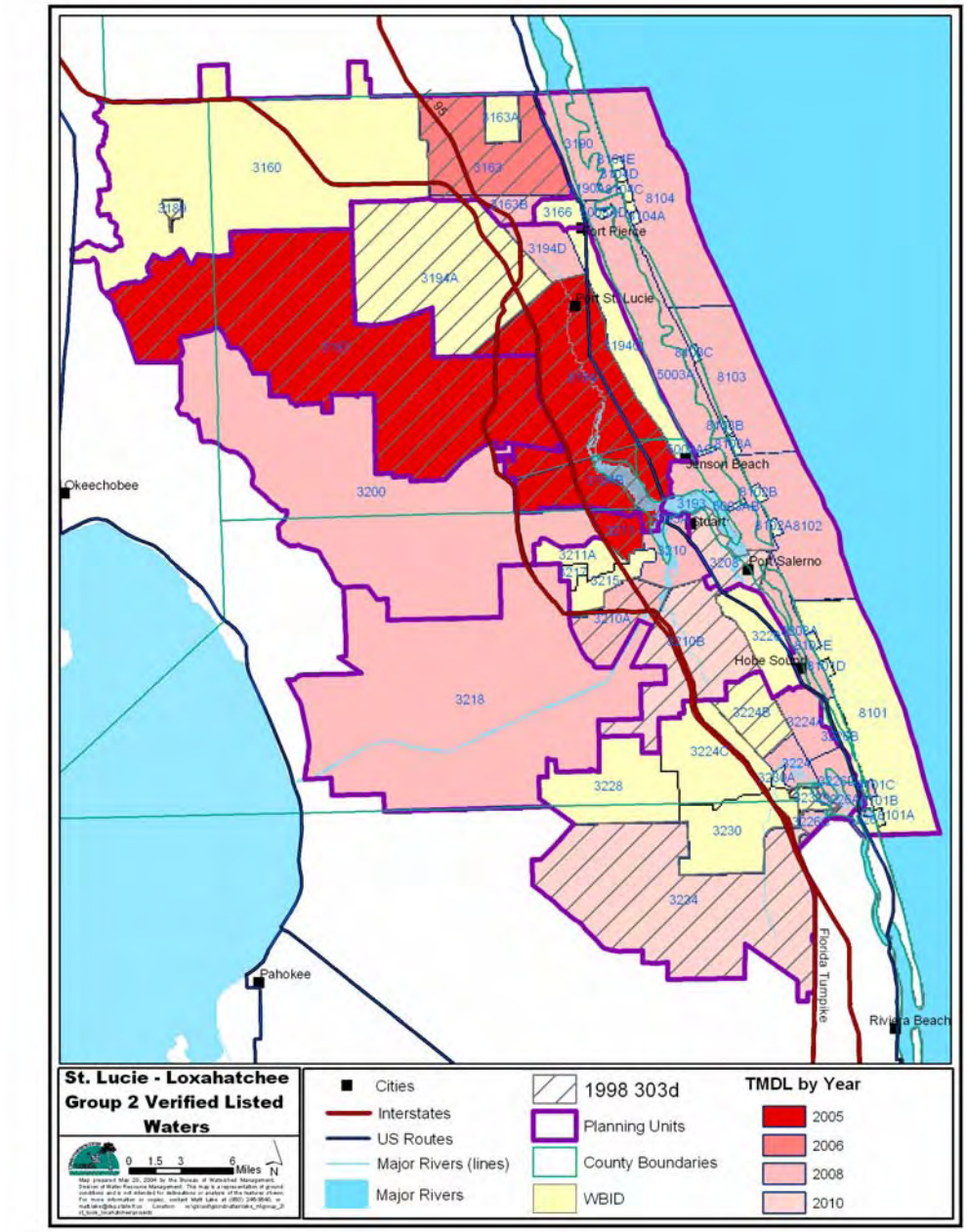

Figure 2: St. Lucie / Loxahatchee River Basin. WBID 3194 is on the 1998 303(d) list for Fecal Coliform.

2. PROBLEM DEFINITION

Florida's final 1998 Section 303(d) list identified WBID 3194 in the St. Lucie River Basin as not supporting water quality standards (WQS) due to coliform bacteria. After assessing all readily available water quality data, EPA is responsible for developing a fecal coliform TMDL in WBID 3194, North St. Lucie. The location of WBID 3194 is shown in Figure 2. The TMDL addressed in this document are being established pursuant to EPA commitments in the 1998 Consent Decree in the Florida TMDL lawsuit (Florida Wildlife Federation, et al. v. Carol Browner, et al., Civil Action No. 4: 98CV356-WS, 1998).

WBID 3194 is designated as a Class III marine water. The designated use of Class III waters is recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife. Class III waters are further categorized based on fresh or marine waters. Water quality criteria for fecal and total coliform do not vary between Class III fresh or marine waters.

3. WATERSHED DESCRIPTION

As discussed in the introduction, FDEP manages water resources based on river basins. The river basins are organized from large groups of major river basins to smaller watersheds called planning units, and finally to small waterbody polygons called WBIDs. The St. Lucie River Basin, North St. Lucie Planning Unit, and North St. Lucie WBID are described next. The following information is from the 2003 FDEP Basin Status Report for St. Lucie and Loxahatchee. In the St. Lucie Basin, most of the land in the non-coastal areas is used for the production of citrus and beef cattle. The extensive network of canals that drains these agricultural areas transports storm-water runoff containing nutrients, sediment, bacteria, and other pollutants. These reach the natural drainage-ways (such as the North and South Forks of the St. Lucie River) and ultimately the St. Lucie Estuary and the South Indian River Lagoon. The St. Lucie Canal (C-44), the inland waterway that connects Lake Okeechobee to Florida's east coast, transports regulated releases of water from Lake Okeechobee and runoff from agricultural areas within the C-44 basin. Other major canals also transport storm-water from inland agricultural areas to the estuary. Canals C-23 and C-24 discharge water into the North Fork of the St. Lucie River and the C-25 Canal discharges to the Indian River Lagoon. These canals transport loads of nutrients and eroded sediment to the estuary and slugs of fresh water that create fluctuations in estuarine salinity levels. Urban and residential areas continue to expand in the coastal areas, with polluted urban storm-water runoff and seepage from septic tanks also contributing to the water quality problems in streams and canals. As a result, parts of the St. Lucie Estuary (SLE) appear to be impaired by nutrients, copper, and low levels of DO. Nutrient loads, salinity fluctuations, and accumulations of sediment stress the estuarine ecology. Other evidence of impairment was gathered for the SLE segments in a FDEP South East District biological survey (Graves et al., June 2002). Sediment accumulation, decline of sea-grasses and oysters, algal blooms, fish kills, and low diversity of benthic macroinvertebrates in the SLE comprise this body of evidence.

WBID 3194 is in the North St. Lucie planning unit of the St. Lucie Basin. It extends from Ft. Pierce Inlet to the St. Lucie Inlet and westward to the C-24 Canal. Historically it has drained naturally into the St. Lucie Estuary and includes the North Fork St. Lucie River and its main tributaries, Tenmile Creek, and Fivemile Creek. WBID 3194 is 48% residential as shown in Table 1 which shows the land-use and land-cover distribution. The planning unit also includes the North St. Lucie Water Control District, located in the northern part where drainage is to Tenmile Creek, C-25 Canal, and the C-24 Canal. The North St. Lucie planning unit is located in eastern St. Lucie County and includes Port St. Lucie and the western half of Ft. Pierce, the western part of Stuart, as well as Palm City, North River Shores, and Lighthouse Point. This watershed is now greatly modified by canals. The eastern terminus of the C-24 Canal is located in this North St. Lucie planning unit. Water from C-24 is released to the North Fork of the St. Lucie River via the C-23A Canal. Figure 3 is a composite map of this planning unit that shows potentially impaired waters and potential point sources of pollution.

Approximately 14 percent of this planning unit has been identified as wetland and 12 percent as upland forests. The wetland areas are located primarily in two areas, along the North Fork of the St. Lucie River and in the Savannas wetland. The Savannas State Reserve is an Outstanding Florida Water (OFW). All waters in this planning unit are designated as Class III, including canals. Straightening and channelization have significantly modified the North Fork of the St. Lucie River, a state aquatic preserve. These modifications have reduced the river system's ability to filter sediment and attenuate nutrients and have dramatically reduced the wetlands that provide habitat. Sediment transported into the North Fork has been accumulating in abnormal quantities in the river bed (Gardner, 1984). The North Fork forms the upper segment of the SLE. Adverse ecological impacts to the estuary caused by the canal discharges of nutrients, sediment, and fresh water are well documented. A water quality study on Tenmile Creek, the major tributary to the North Fork, identified significant concentrations of pesticides in the water (most notably malathion and ethion) that are apparently related to citrus farming in the Tenmile Creek Basin (Graves and Strom, June 1995). Fish kills and the documentation of degraded biological communities in Tenmile Creek may be attributable to the pesticide load. Sedimentation in Tenmile Creek and the North Fork due to canal erosion in the NSLWCD has also been documented as a concern (NSLWCD, 2000).

A significant portion of this planning unit is in agricultural land use, primarily citrus production. Individual citrus growers are participating in the BMP program to reduce pollutant loadings to storm-water. Several programs supported by the St. Lucie River Issues Team are focused on reducing irrigation volumes that directly affect the volume of polluted runoff and the magnitude of transported sediment from irrigated citrus groves. In the Citrus Irrigation Conversion project supported by NRCS, cost-share contributing growers in the North St. Lucie planning unit are converting to low-volume irrigation equipment to help reduce discharges. Currently, storm-water transported by canals C-23 and C-24 enters directly into the North Fork St. Lucie River through tidal structures. The IRL South Feasibility Study includes the northern diversion component that will result in a significant improvement to the quality and better regulation of water discharged to the North Fork. Under this component, storm-water from the C-23 and C-24 Canals will be diverted into one of two reservoirs to be constructed in the along the eastern boundary of the

C-24 and C-23 basins (C-23/24 North and South Reservoirs). Water from these reservoirs could be returned to the canals to equalize storage, to supply water, or to be diverted to the C-23/24 storm-water treatment area (STA), located in the northwestern part of this planning unit, where it would be treated. From the STA, the treated water would be routed via a bypass canal to Tenmile Creek and into the North Fork. The northern diversion component will improve the quality of water and the timing of fresh water being delivered to the North Fork and the SLE. Hydrologic models predict that it can come close to achieving pre-drainage distribution flows (quantity) to the North Fork. The Feasibility Study also includes a significant project to restore the natural hydrology of the North Fork by reconnecting river floodplains and oxbows and returning the river to a condition similar to its historic path. The North Fork Floodplain Restoration component will increase the capacity of the river to accommodate flows and improve water quality and habitat. This component is also a St. Lucie River Issues Team project. The North Fork Floodplain Restoration project is already underway. It was one of the numerous water quality improvement projects sponsored by the St. Lucie River Issues Team. Other Issues Team projects in this planning unit that are funded and underway include

• the Tenmile Creek Restoration (a Central and Southern Florida [C&SF] Ecosystem Restoration Critical Project that includes construction of a temporary/seasonal storm-water basin to provide treatment and flow equalization of water in Tenmile Creek);
• NSLR Canal Retrofits and NSLWCD Bank Restoration projects, under the Issues Team umbrella, addressing soil erosion and sediment transported by canals;
• the Platt's Creek restoration project that also provides treatment of water entering the North Fork in St. Lucie County; and
• several urban storm-water retrofit projects benefiting the North Fork and SLE. (FDEP, 2003, Basin Status Report)

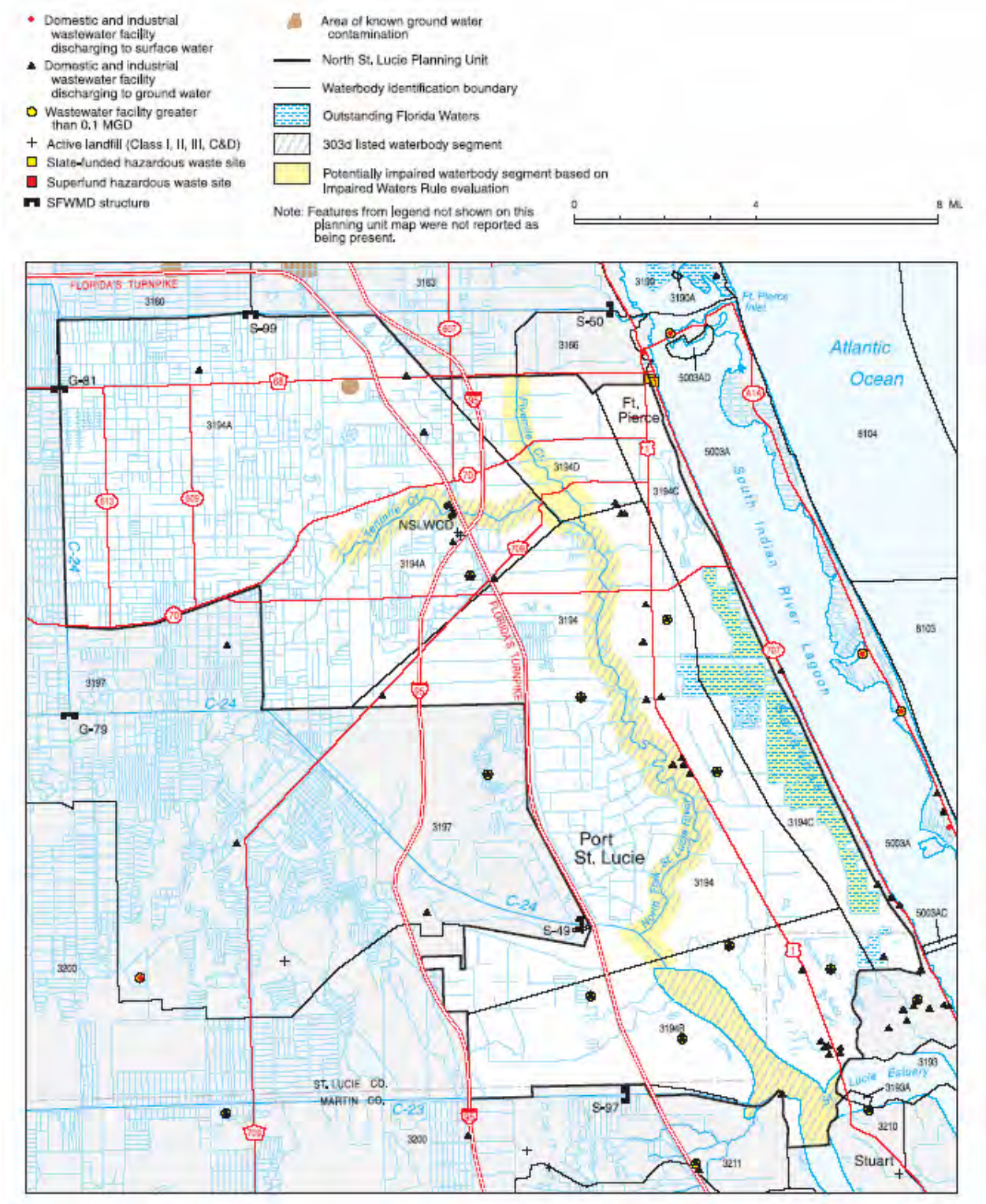

Figure 3: North St. Lucie Planning Unit

Table 1: Land Cover Distribution for WBID 3194 in acres and percentage.

Residential (1100-1390)	17367	48%
Commercial, Industrial, Public (1400, 1500, 1800)	2319	6%
Agriculture (2000 series)	1682	5%
Rangeland (3000 series)	3402	9%
Forest (4000 series)	5716	16%
Water (5000 series)	1507	4%
Wetlands (6000 series)	3140	9%
Barren & Extractive (7000, 1600)	274	1%
Transportation & Utilities (8000 series)	974	3%
TOTAL (acres)	36381	

4. WATER QUALITY STANDARD FOR FECAL COLIFORM BACTERIA , AND TARGET IDENTIFICATION

The water quality criteria for protection of Class III waters are established by the State of Florida in the Florida Administrative Code (F.A.C.), Section 62-302.530. The individual criteria should be considered in conjunction with other provisions in water quality standards, including Section 62-302.500 F.A.C. [Surface Waters: Minimum Criteria, General Criteria] that apply to all waters unless alternative or more stringent criteria are specified in F.A.C. Section 62-302.530.

Fecal coliforms are a subset of the total coliform group and indicate the presence of fecal material from warm-blooded animals. Total coliform bacteria generally indicate the presence of soil-associated bacteria and result from natural influences on a water body such as rainfall runoff as well as sewage inflows. The most probable number (MPN) or membrane filter (MF) counts per 100 milliliter (ml) of fecal coliform bacteria shall not exceed a monthly average of 200, nor exceed 400 in 10 percent of the samples, nor exceed 800 on any one day. Monthly averages shall be expressed as geometric means based on a minimum of 10 samples taken over a 30-day period. The geometric mean criteria reflect chronic or long-term water quality conditions whereas the 400 and 800 values reflect acute or short-term conditions.

The target for this TMDL is the daily 800 counts per 100 ml and the “not to exceed 400 in 10 percent of the samples” criteria, since enough monthly data was not collected to evaluate the monthly average 200 criteria. When flow data are available in the WBID, the fecal coliform TMDLs are expressed as daily loads in units of MPN per day. The fecal coliform TMDLs are also expressed in terms of the percent reduction required to achieve water quality standards. When flow data are not available in the WBID or due to hydrologic and/or geologic conditions it is not possible to estimate flow (i.e., tidal influence or karst geologic formation), the TMDLs are expressed only as percent reductions.

It is appropriate to use the more stringent of the acute criteria for fecal coliform TMDL development as the data indicates violations of the standard are typically related to storm events,

which are short-term in nature. Violations of the chronic criteria are typically associated with point sources or non-point source continuous discharges (e.g., leaking septic systems) and typically occur during all weather conditions. Targeting the acute criteria should be protective of the chronic criteria.

5. WATER QUALITY ASSESSMENT AND DEVIATION FROM TARGET

To determine the status of surface water quality in Florida, three categories of data – chemistry data, biological data, and fish consumption advisories – were evaluated to determine potential impairments. The level of impairment is defined in the Identification of Impaired Surface Waters Rule (IWR), Section 62-303 of the Florida Administrative Code (F.A.C.). The IWR defines FDEP's threshold for identifying water quality limited WBIDs to be included on the state's 303 (d) list. In addition, all waters on the 1998 303 (d) list that were not delisted remain on the current 303 (d) list and require TMDLs. The North St. Lucie WBID is on FDEP's planning list for fecal coliform bacteria. EPA assessed this WBID and concluded that it is impaired, and a fecal coliform TMDL must be developed.

FDEP maintains ambient monitoring stations throughout the basin. All data collected at monitoring stations within the impaired WBID are used in the analysis. Table 2 provides a list of the monitoring stations and shows that 19 of the samples were from the North Fork of the St. Lucie River and 10 samples were from other waters in the WBID.

Table 2: Monitoring Stations used in the Development of this Fecal Coliform TMDL

Station ID	Station Name	Number of Observations
21FLA 28010009	No Fork St Lucie Riv Sr 712	12
21FLA 28010310	N Fk St. Lucie R South Of Midway Rd	2
21FLGW 18845	SFB-SL-1055 Unnamed Small Lake	1
21FLGW 20004	SFB-SS-1001 Unnamed Small Stream	1
21FLGW 20030	SFB-SS-1065 Unnamed Small Stream	1
21FLWPB 28010405	Canal @ Midport Rd PSL near Lyngate Park	7
21FLWPB 28010879	North Fork St Lucie Riv At Port St Lucie Blvd	5

Table 3. Summary of Fecal Coliform Monitoring Data in WBID 3194

Number of Samples	30-Day Geometric Mean[1]	% Samples > 400 (MPN/100mL)	% Samples > 800 (MPN/100mL)	Minimum Concentration (MPN/100mL)	Maximum Concentration (MPN/100mL)
29	N/A	38%	17%	2	250000

Notes:

1. N/A = not applicable since less than 10 samples collected within a 30-day period to evaluate criteria.

Violations of the fecal coliform criteria often occur in response to rainfall events. Precipitation data collected at stations near the impaired WBID was plotted with the fecal coliform results to identify conditions when violations occurred (see Figure 4). Due to the multi-year range of the data, the rainfall relationship is not apparent in this plot. Figure 5 was developed to clearly demonstrate this coliform response to rainfall. Since fecal coliform is washed into streams and canals with storm-water, the rainfall immediately prior to the sampling event is important. The total rainfall on the sampling day plus the two prior days was used to demonstrate this relationship between coliform concentration and rainfall, and it is shown in Figure 5. The correlation coefficient of 0.4 indicates that much of the variation in fecal coliform can be explained by rainfall. The rainfall data used in this analysis was from four sources, the St. Lucie County and West Palm Beach Airport NOAA stations, the South Florida Water Management District S49_R station at S-49 spillway on canal C-24 near the Florida Turnpike, and the Ft. Pierce station of the Florida Automated Weather Network (FAWN).

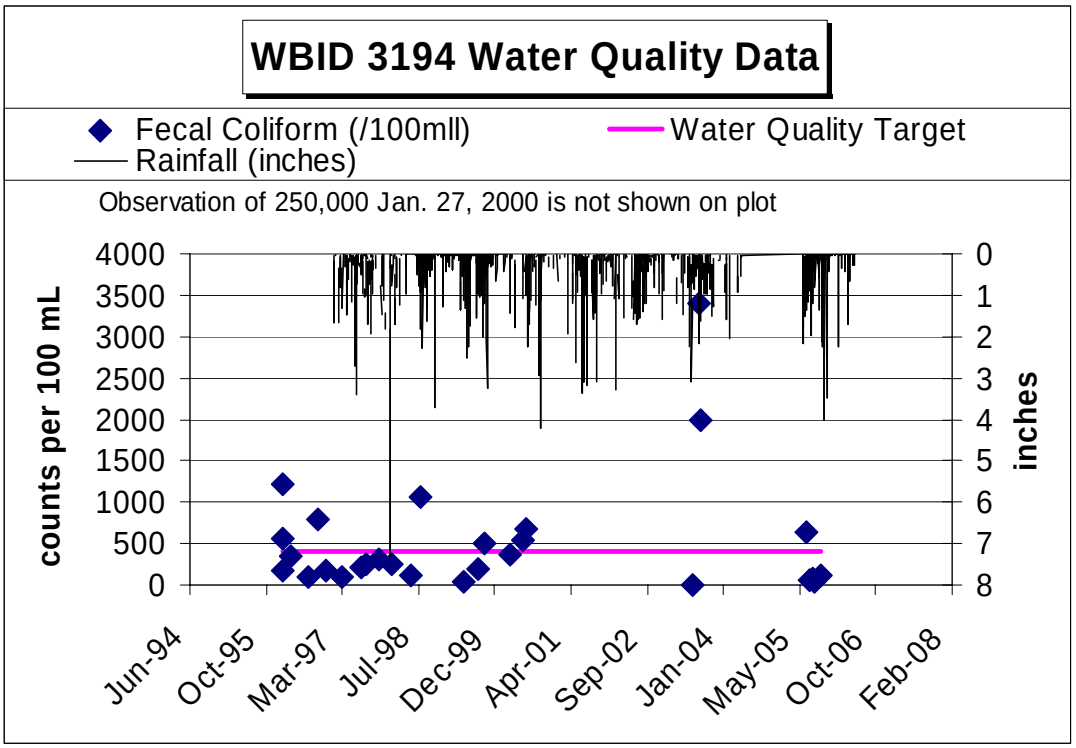

Figure 4: Fecal Coliform and Rainfall

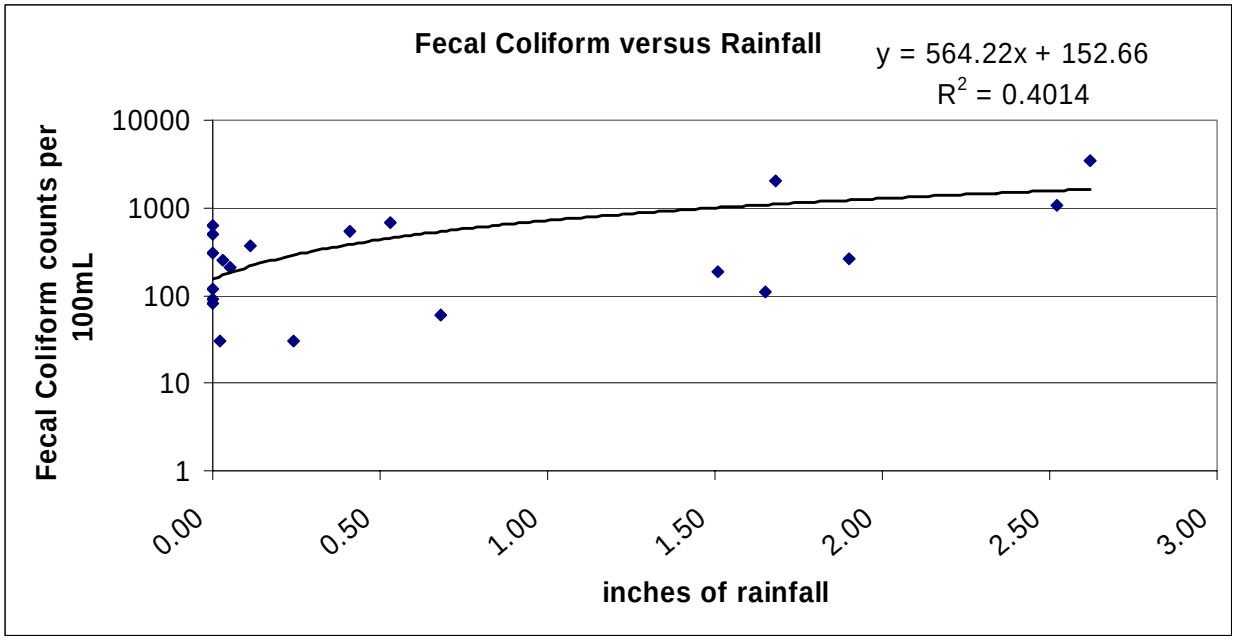

Figure 5: Correlation of Fecal Coliform versus Rainfall

6. SOURCE ASSESSMENT

An important part of the TMDL analysis is the identification of source categories, source subcategories, or individual sources of coliform bacteria in the watershed and the amount of pollutant loading contributed by each of these sources. Sources are broadly classified as either point or non-point sources.

A point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Point source discharges of industrial wastewater and treated sanitary wastewater must be authorized by National Pollutant Discharge Elimination System (NPDES) permits. NPDES permitted facilities discharging treated sanitary wastewater or stormwater (i.e., Phase I or II MS4 discharges) are considered primary point sources of coliform.

Non-point sources of coliform are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance at a single location. These sources generally, but not always, involve accumulation of bacteria on land surfaces and wash off as a result of storm events. Typical non-point sources of coliform include:

- Wildlife
- Agricultural animals
- Onsite Sewer Treatment and Disposal Systems (septic tanks)
- Urban development (outside of Phase I or II MS4 discharges)

A geographic information system (GIS) tool, was used to display, analyze, and compile available information to characterize potential bacteria sources in the impaired WBID. This information includes land use, point source dischargers, soil types and characteristics, population data (human and livestock), and stream characteristics.

6.1. Point Sources

According to the FDEP database, there are 36 permitted wastewater treatment facilities in the North St. Lucie planning unit (26 domestic wastewater, 9 industrial wastewater, 1 other). None of
these are permitted to discharge directly to surface water. The largest facility, the Martin County Utilities North domestic wastewater plant, has a design capacity of 1.2 mgd. There is 1 permitted solid waste landfill in the planning unit, the St. Lucie County Landfill, and 1 permitted construction and demolition (C&D) debris landfill. There are no state-funded or NPL hazardous waste sites, although there is 1 delineated ground water contamination area (for EDB). Also in this planning unit, there are 4 dry cleaning facilities and more than 100 reported discharges from petroleum storage facilities. Figure 3 shows permitted wastewater treatment facilities, landfills, and delineated areas in the North St. Lucie River planning unit.

Municipal Separate Storm Sewer Systems (MS4s) may also discharge bacteria to water-bodies in response to storm events. Large, medium, and small MS4s serving populations greater than 50,000 people, or with an overall population density of 1,000 people per square mile, are required to obtain a NPDES storm water permit. There are three MS4 permits in Martin county; Martin County (FLR04E013), City of Stuart (FLR04E031), and Sewall's Point (FLR04E044). There are also three MS4 permits in St. Lucie County; Fort Pierce (FLR04E065), Port St. Lucie (FLR04E001) and St. Lucie County (FLR04E029).

6.2. Non-point Sources

Runoff from urban and agricultural areas impacts water quality in the North Fork and its tributaries. Urban (48 percent residential and 6 percent commercial) and forest (16 percent of WBID) are the predominant land uses in the WBID. Medium and high density residential development makes up the largest percentage of urban land in the WBID.

6.3. Wildlife

Wildlife deposit bacteria in their feces onto land surfaces where it can be transported during storm events to nearby streams. Bacteria load from wildlife is assumed background, since the contribution from this source is small relative to the load from urban and agricultural areas. Water fowl (e.g., egrets, ducks, wood storks, herons) often frequent storm-water ponds. Depending on the number of birds, the contributions of fecal coliform could result in stream concentrations above the criteria.

6.4. Agricultural Animals

Agricultural animals are the source of several types of coliform loadings to streams, that impact water quality. This source includes agriculture runoff from pastureland and cattle in streams. The land use within the impaired WBID is 14 percent agricultural and rangeland (Table 1), so this landuse likely discharges a significant amount of the bacteria load.

The USDA National Agricultural Statistics Service (NASS) compiles Census of Agriculture data by county for virtually every facet of U.S. agriculture (USDA, 2002). The "Census of Agriculture Act of 1997" (Title 7, United States Code, Section 2204g) directs the Secretary of Agriculture to conduct a census of agriculture on a 5-year cycle collecting data for the years ending in 2 and 7. Livestock inventory from the 2002 Census of Agriculture reports for St. Lucie and Martin Counties are listed in Table 4. Cattle and calves are the predominate livestock. Confined Animal Feeding Operations (CAFOs) are not known to operate in either St. Lucie or Martin County.

In 2002, NASS reported 221,537 acres of farmland in St. Lucie County and 206,198 acres of farmland in Martin County.

Table 4. Livestock Inventory by County (source: NASS, 2002)

Livestock (inventory)	St. Lucie	Martin
Cattle and calves	31,944	27,279
Hogs and Pigs	394	439

6.5. Onsite Sewerage Treatment and Disposal Systems (Septic Tanks)

Onsite sewage treatment and disposal systems (OSTDs) including septic tanks are commonly used where providing central sewer is not cost effective or practical. When properly sited, designed, constructed, maintained, and operated, OSTDs are a safe means of disposing of domestic waste. The effluent from a well-functioning OSTD is comparable to secondarily treated wastewater from a sewage treatment plant. When not functioning properly, OSTDs can be a source of nutrient (nitrogen and phosphorus), pathogens, and other pollutants to both ground water and surface water. The State of Florida Department of Health (www.doh.state.fl.us/environment/ostds/statistics/ostdsstatistics.htm) publishes septic tanks data on a county basis. Table 5 summarizes the cumulative number of septic systems installed since the 1970 census. The data does not reflect septic tanks removed from service.

Table 5. County Estimates of Septic Tank Installations (FDEP, 2004)

County	Number Septic Tanks (1970-2002)
St. Lucie	43,022
Martin	27,284

6.6. Urban Development

Fecal coliform loading from urban areas is attributable to multiple sources including storm-water runoff, leaks and overflows from sanitary sewer systems, illicit discharges of sanitary waste, runoff from improper disposal of waste materials, leaking septic systems, and domestic animals.

In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of non-point source pollution by requiring new development and redevelopment to treat storm-water before it is discharged. The Stormwater Rule, as outlined in Chapter 403 Florida Statutes (F.S.), was established as a technology-based program that relies upon the implementation of BMPs that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Chapter 62-40, F.A.C. Florida's stormwater program is unique in having a performance standard for older storm-water systems that were built before the implementation of the Stormwater Rule in 1982. This rule states: "the pollutant loading from older storm-water management systems shall be reduced as needed to restore or maintain the beneficial uses of water" (Section 62-4-.432 (5) (c), F.A.C.).

Nonstructural and structural BMPs are an integral part of the State's storm-water programs. Nonstructural BMPs, often referred to as "source controls", are those that can be used to prevent the generation of NPS pollutants or to limit their transport off-site. Typical nonstructural BMPs include public education, land use management, preservation of wetlands and floodplains, and minimizing impervious surfaces. Technology-based structural BMPs are used to mitigate the increased storm-water peak discharge rate, volume, and pollutant loadings that accompany urbanization.

7. ANALYTICAL APPROACH

The approach for calculating coliform TMDLs depends on the number of water quality samples and the availability of flow data. When long-term records of water quality and flow data are not available, the TMDL is expressed as a percent reduction. Load duration curves are used to develop TMDLs when significant data are available to develop a relationship between flow and concentration. Load duration curves utilize a mass balance approach to estimate loadings transported in the stream. For the load duration curve TMDLs, the target is the acute criteria. Since only 29 water quality measurements were available this fecal coliform TMDL is expressed as a percent reduction.

7.1. Percent Reduction Approach for TMDL Development

Under this "percent reduction" method, the percent reduction needed to meet the applicable criterion is calculated based on a percentile of all measured concentrations. The (p X 100) percentile is the value with the cumulative probability of p. For example, the 90th percentile has a cumulative probability of 0.90. The 90th percentile is also called the 10 percent exceedance event because it will be exceeded with the probability of 0.10. Therefore, considering a set of water quality data, 90 percent of the measured values are lower than the 90th percentile concentration and 10 percent are higher. In order to apply this to the TMDL target, remember that the water quality standard states the fecal coliform concentration shall not exceed 400 counts per 100 ml in 10 percent of the samples. Therefore, 400 should be targeted with a percentile slightly larger than 90 to ensure less than 10 percent of the values exceed 400. For this TMDL, 400 counts per 100 milliliter was targeted as the 95th percentile. This will ensure that only 5 percent of the data exceed a concentration of 400. There are many formula for determining the percentile and these can be found in many text books on statistics. In this TMDL the Hazen formula was used since it is recommended in Hunter's Applied Microbiology (2002) article concerning bacteria in water. The TMDL percent reduction required to meet the coliform criteria is based on the following equation:

Percent Reduction = (existing 95th percentile concentration – criteria) / existing 95th percentile concentration × 100 (Equation 2)

In WBID 3194 the 95th percentile concentration is 3400 MPN/100ml, and an 88 percent reduction is necessary to meet the water quality target of 400 MPN/100 ml 95 percent of the time. The "not to exceed 800" standard would result in a reduction of about 99.7 percent because of the maximum reported value of 250,000 counts per 100 ml. However, the actual value was not 250,000, but was unknown. The laboratory designated the actual number of colonies was too numerous to count. Therefore the value of 250,000 is not appropriate to use by itself to calculate a TMDL based on the 800 standard. On the other hand, this value was included in the set of values used to calculate the 95th percentile. With only 29 samples, it is important to utilize as much information as possible, and it is known that the fecal coliform concentration was extremely high in that sample.

8. DEVELOPMENT OF TOTAL MAXIMUM DAILY LOADS

The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions. A TMDL can be expressed as the sum of all point source loads (Waste Load Allocations), non-point source loads (Load Allocations), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$TMDL = \Sigma WLAs + \Sigma LAs + MOS$$

The objective of a TMDL is to allocate loads among all of the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and water quality standards achieved. 40 CFR §130.2 (i) states that TMDLs can be expressed in terms of mass per time (e.g. pounds per day), toxicity, or other appropriate measures. The TMDL for the North St. Lucie WBID is expressed as a percent reduction.

8.1. Critical Conditions

The critical condition for non-point source coliform loading is an extended dry period followed by a rainfall runoff event. During the dry weather period, coliforms build up on the land surface, and are washed off by rainfall. The critical condition for point source loading occurs during periods of low stream flow when dilution is minimized. Water quality data have been collected during both time periods. Most violations occur during median to high flow conditions. Critical conditions are accounted for in the analyses by using the entire period of record of measured flows (when available) and all water quality data available for the WBID.

8.2. Margin of Safety

TMDLs shall include a margin of safety that takes into account any lack of knowledge about the pollutant loading and in-stream water quality. In this case the measured water quality was used directly to determine the reduction to meet the water quality standard. In this case the lack of knowledge concerns the data, how well it represents the true water quality, and the estimation of the exceedance probability. There are two methods for incorporating a MOS in the analysis: 1) implicitly incorporate the MOS using conservative model assumptions to develop allocations; or 2) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations. In the North St. Lucie WBID TMDL, an implicit MOS was used by targeting reductions that will result in no more than 5 percent of the samples exceeding a concentration of 400 counts per 100 ml even though the standard requires less than 10 percent exceedance. In addition, this TMDL requires a very high reduction of 88 percent.

8.3. Determination of TMDL, LA and WLA

The TMDL values represent the maximum daily load the stream can assimilate and maintain water quality standards. The TMDLs are based on the daily 800 counts per 100 ml and the ”not to exceed 400 in 10 percent of the samples” Class III WQS and are expressed in units of MPN per day. TMDL components for the impaired water-bodies required to achieve the numerical criterion are summarized in Table 6.

Table 6. Summary of TMDL Components

Stream Name / WBID	Parameter	WLA	LA	TMDL	Percent Reduction

		Continuous	**MS4**			
North St. Lucie (3194)	Fecal Coliform	N/A	88% reduction	88% reduction	88% reduction	88% reduction

8.4. Waste Load Allocations

The waste load allocation for municipally separated storm sewer systems contributing pollutants to WBID 3194 is an 88 percent reduction from existing loads. There are six MS4 permits near this WBID. These are Martin County (FLR04E013), City of Stuart (FLR04E031), Sewall's Point (FLR04E044), Fort Pierce (FLR04E065), Port St. Lucie (FLR04E001) and St. Lucie County (FLR04E029).

8.5. Load Allocations

There are two modes of transport for non-point source coliform bacteria loading into the stream. First, fecal coliform loading from failing septic systems and animals in the stream are considered direct sources of coliform to the stream, since they are independent of precipitation. The second mode involves coliform loadings resulting from accumulation on land surfaces transported to streams during storm events. Data from this WBID shows violations during wet weather and dry weather, so both direct and indirect sources should be targeted by the reductions.

8.6. Seasonal Variation

Seasonal variation was incorporated in the load curves by using the entire period of record of flow recorded at the gages. Seasonality was also addressed by using all water quality data associated with the impaired WBIDs, which was collected during multiple seasons.

8.7. Recommendations

Determining the source of bacteria in waterbodies is the initial step to implementing a coliform TMDL. FDEP employs the Basin Management Action Plan (B-MAP) as the mechanism for developing strategies to accomplish the necessary load reductions. Components of a B-MAP are:

- Allocations among stakeholders
- Listing of specific activities to achieve reductions
- Project initiation and completion timeliness
- Identification of funding opportunities
- Agreements
- Local ordinances
- Local water quality standards and permits
- Follow-up monitoring

9. REFERENCES

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APPENDIX A: WATER QUALITY REMARK CODES

Table 7: Guide to Water Quality Remark Codes (Rcode column in data tables)

Remark Code	Definition	Use in TMDL
A	Value reported is mean of two or more samples	Data included in analysis as reported
B	Result based on colony counts outside the acceptable range	Data included in analysis as reported
E	Extra sample taken in compositing process	Data included as average
I	The value reported is less than the practical quantification limit and greater than or equal to the method detection limit.	Data included in analysis as reported
J	Estimated. Value shown is not a result of analytical measurement.	Data included in analysis as reported
K	Off-scale low. Actual value not known, but known to be less than value shown	Data included in analysis as reported
L	Off-scale high. Actual value not known, but known to be greater than value shown	Data included in analysis as reported
Q	Sample held beyond normal holding time	Data used in analysis – holding samples on ice slows the metabolism of the organisms resulting in no appreciable growth. Actual concentration is expected to be at least as high as the value reported.
T	Value reported is less than the criteria of detection	Data included in analysis if the reported value is below criteria; otherwise, reported value is not used in the analysis
U	Material was analyzed for but not detected. Value stored is the limit of detection.	Data not included in analysis
<	NAWQA – actual value is known to be less than the value shown	Data included in analysis
Z	Too many colonies were present to count (TNTC), the numeric value represents the filtration volume	Data not included in analysis